Changes in Growth, Morphology and Photosynthetic Attributes by Drought in Bitter Gourd (*Momordica charantia* L.)

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**Abstract:** Water is one of the major limiting abiotic factor which is important for plant growth and other processes. Water stress is a major environmental stress that effects agriculture production worldwide. This experiment was designed to evaluate the water stress (drought) effect on bitter gourd. Experiment was conducted at University of Gujrat, Pakistan during 2015. There were four levels of drought including control i.e. 0, 25, 50, 75% drought. Experiment was laid down in completely randomized design (CRD) with three replications. It was observed that most of the morphological and photosynthetic attributes decreased with the increase in drought levels. Maximum reduction was noted at 75% of drought. It was concluded that bitter gourd can tolerate drought upto 25% which have non significant reduction as compared to control.

**Key words:** Drought • Growth • Bitter gourd • Morphology • Pigments

**INTRODUCTION**

Water is essential for the physico-chemical processes of plants. It also effects the plant growth and development. It is required for the survival of all living organisms. Water comprises about 70-90% body of fresh weight but only a small fraction of water is utilized by plants. Plant growth and productivity severely affected by water stress. If the stress is prolonged, plant is not able to perform its proper functions. The water stress leads to many changes in plants; like stunted growth, wilting of leaves, death of leaves etc. Most of the absorbed water in plants is lost through transpiration and only about 1% or less is used in the various biochemical processes [1]. Whereas, bitter gourd require less water for its growth. Bitter gourd is also referred as “Krela” or “Balsam pear”. It is tropical or temperate vegetable originates in South East-Asia. It belongs to family Cucurbitaceae and is fast growing climbing vine with thin stem and tendrils which require support for climbing. The fruit of bitter gourd is 8-15cm in length and 4-20cm in width, the surface of bitter gourd is rough. Bitter gourd (*Momordica charantia* L.), fruit-vegetable is popular as a medicinal vegetable [2].

Bitter gourd is beneficial for human health; it involves in the treatment of many diseases including Diabetes, skin diseases, cholesterol level, pancreatic cancer, weight loss etc. As water is essential for bitter gourd, its drought effect create negative impact on growth of bitter gourd. Shoot and root growth were significantly reduced by osmotic stress induced with polyethylene glycol [3]. Water deficit cause symptom in scaleof few minutes (cause wilt crop, stomatal closure), weekly (change growth and flowering), monthly (degradation of total biomass) [4]. Drought stresscaused accumulation of prolin in potato leaves. Water stress occurs when the rate of transpiration exceeds the absorption and the water transportation in plants [5]. Drought caused reduction in root biomass. The shoot, root ratio in B. mutica and B. humdicola increased in response to drought tolerance at the expense of a reduction in root yield down to 50 cm depth [6]. The main purpose of this research was to assess the effect of drought on bitter gourd in relation to morphology, growth and photosynthetic attributes.

**MATERIALS AND METHODS**

Pot experiment was performed in Botanical garden of University Of Gujrat, Pakisitan. Seeds of bitter groud was purchased from Kisan Beegh store Kharian, Pakisitan. Seeds were sown in sandy loam soil. Different drought levels were applied after 14 days of germination. There were following levels of drought:
The drought levels were applied by measuring the saturation percentage. The design used was Completely Randomized Design (CRD). There were four treatments with three replicates. The levels of drought were maintained for 18 days then data for different growth and physiological parameters were recorded. The attributes under consideration were root and shoot lengths, shoot and root fresh and dry weights, leaf area and photosynthetic attributes. Shoot and root lengths (cm) were measured with the help of a meter rod from stem base to the top. Shoot fresh weight (g) was calculated with an electrical balance. Plant samples were placed in oven at 65°C. After 4-days shoot and root dry weight (g/pot) was calculated with the help of electric balance. Photosynthetic rates were measured by IRGA. Photosynthetic pigments were calculated by the following formula:

- Chlorophyll a (mg/g) = 12.7×OD663 - 2.69×OD645×V/1000×W
- Chlorophyll b (mg/g) = 22.9×OD645 - 4.68×OD663×V/1000×W
- Carotenoids (mg/g) = OD480 + (0.114×OD663 - 0.638×OD645)

Analysis of variance technique was employed for carrying out statistical analysis of data collected [10]. Various treatment means were compared with Duncan’s New Multiple Range (DMR) Test.

RESULTS AND DISCUSSION

Data regarding root and shoot lengths are given in Fig. 1-2 and means squares of ANOVA are presented in Table 1. The effect of drought was non-significant on lengths of bitter gourd. It was noted from DMRT comparison that lengths are decreased with the increase of drought levels and it retarded the growth of bitter gourd. Maximum reduction was noted in T3 (75% drought).

Table 1 shows that the effect of drought was significant on fresh and dry weights of shoots and roots. Maximum shoot and root fresh weights were measured in T0 and minimum weights were present in T1 (Fig. 3-4).
Table 1: Effect of drought on morphological attributes of bitter gourd

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>df</th>
<th>Root Length (cm)</th>
<th>Shoot Length (cm)</th>
<th>Shoot Fresh Weight (g)</th>
<th>Root Fresh Weight (g)</th>
<th>Shoot Dry Weight (g)</th>
<th>Root Dry Weight (g)</th>
<th>No. of Leaves</th>
<th>Leaf Area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>3</td>
<td>22.38 **</td>
<td>37.63 ns</td>
<td>0.279 ***</td>
<td>0.241 ***</td>
<td>0.012 **</td>
<td>0.0937 **</td>
<td>17.125 ns</td>
<td>7.216 ns</td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>10.43</td>
<td>12.217</td>
<td>0.0023</td>
<td>0.002</td>
<td>3.937</td>
<td>0.004</td>
<td>2.875</td>
<td>7.332</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 2: Effect of drought on physiological attributes of bitter gourd

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>df</th>
<th>Photosynthetic Rate (A)</th>
<th>Transpiration Rate (E)</th>
<th>Stomatal Conductance (g)</th>
<th>Sub-stomatal CO₂ Concentration</th>
<th>Chl a contents (mg/g)</th>
<th>Chl b contents (mg/g)</th>
<th>Carotenoids (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>3</td>
<td>2.804***</td>
<td>1.795***</td>
<td>0.002 ns</td>
<td>1633.125ns</td>
<td>58.983 **</td>
<td>35.102 ns</td>
<td>0.143 **</td>
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<tr>
<td>Error</td>
<td>8</td>
<td>0.015</td>
<td>0.012</td>
<td>4.505</td>
<td>107.625</td>
<td>2.118</td>
<td>56.014</td>
<td>0.007</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Fig. 5: Effect of Drought on Root dry weight (g) of Bitter ground

Fig. 6: Effect of Drought on Shoot dry weight (g) of Bitter ground

Fig. 7: Effect of Drought on Number of leaves/plant of Bitter ground

Fig. 8: Effect of Drought on Leaf area (cm²) of Bitter ground

Dry weights of shoots and roots are presented in Figures 5-6. Dry weights were also decreased with the increase in drought levels. Maximum reduction in dry weights were noted in T₃ for shoot and root weights.

The effect of drought was non significant on number of leaves per plant and leaf area (Table 1). However from DMRT it was revealed that there was minor variations for number of leaves per plant and leaf area. Both these attributes decreased as the drought levels were increased (Fig. 7-8).

From Table 2 it is apparent that the effect of drought was significant on photosynthetic and transpiration rates of bitter gourd. Photosynthetic rate significantly decreased at drought levels of 50 and 75% (Fig. 9). In case of transpiration rate maximum reduction was noted at 75% of drought (Fig. 10).

Effect of drought was non significant on stomatal conductance of bitter gourd (Table 2). From comparison means there were minor changes in stomatal conductance which decreased with the increase in drought levels (Fig. 11). Stomatal CO₂ concentrations had non significant effect of drought (Table 2 and Fig. 12).
Photosynthetic pigments are significantly decreased with the increase in drought levels except chl-b. (Table 2). All these pigments decreased at all levels of drought (Fig. 12-14). Maximum reduction was observed in T₃ as compared to control.

Above results showed that there was significant effect of drought on bitter gourd as it decreased the plant height, plant dry weight, reduction of photosynthetic and
transpiration rate. It was clear from the results obtained from this study, that different levels of water stress have affected the growth of bitter gourd, which indicates that the bitter gourd cultivars differed in their ability to tolerate different levels of water stress [7]. Effect of water stress on bitter gourd growth has been discussed extensively [2, 8]. Although water stress affects most of the functions of plant growth, this effect depends on the level of water stress, the length of time to which the plant is subjected to water stress [9]. There are numerous reports on photosynthetic and metabolites characteristics under water stress [10]. Generally, photosynthesis is inhibited by water stress, also affects photosynthetic components and chloroplastic stress [11]. It was concluded that bitter gourd can tolerate drought up to 25% which have non significant reduction as compared to control.

REFERENCES